PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-320875

(43)Date of publication of application : 16.11.2001

(51)Int.Cl. H02M 3/28
A61B 6/03
H05G 1/54

(21)Application number : 2000-136518

(22)Date of filing : 10.05.2000

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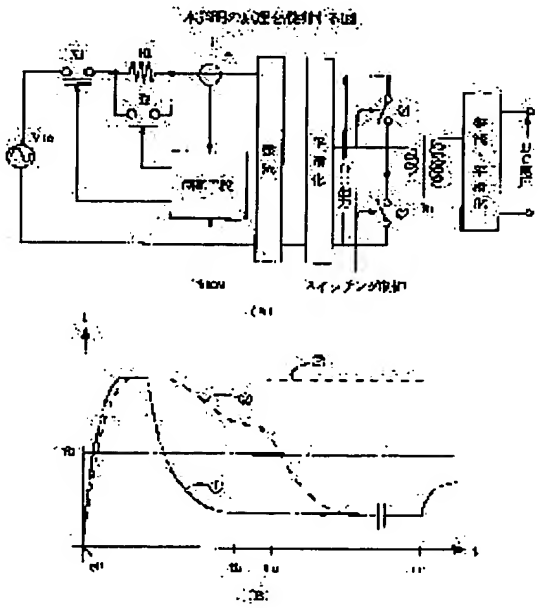
(54) POWER SUPPLY AND X-RAY CT APPARATUS USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a power supply which can quickly shut off the main power supply circuit by accurately detecting a fault when the power switch is turned ON, and an X-ray CT apparatus using the same power supply.

SOLUTION: A switching regulator system power supply comprises a first switch means K1 for opening and closing a main AC power source input circuit, a current limit resistor R1 provided in series with the first switch means for limiting an AC rush current when the power switch is turned ON, a second switch means K2 provided in parallel with the current limit resistor and closed after passage of the first predetermined time ta from the time when the main power supply is turned ON for bypassing a current limit resistor circuit, and a control means 1 for detecting a current value in relation to the AC input and also opening the first switch means K1 when the detected current value exceeds the first predetermined threshold value TH1 after passage of the predetermined time tb from the time when the main power supply is turned ON.



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CLAIMS

[Claim(s)]
[Claim 1] In the power unit of the switching regulator method which carries out switching control of the DC output obtained by rectifying and graduating AC input further, and generates a necessary stabilization DC electrical potential difference The 1st switching means which opens and closes the main power supply input way of AC, and the current-limiting resistance for being prepared in said 1st switching means and serial, and restricting AC rush current of a power up, While detecting the 2nd switching means which is prepared in said current-limiting resistance and juxtaposition, is closed after the 1st predetermined time progress from a main power supply injection, and bypasses said current-limiting resistance circuit, and the current value concerning AC input The power unit characterized by having the control means which opens the 1st switching means when said detection current value at the time of progress of the 2nd predetermined time is over the 1st predetermined threshold from the main power supply injection.
[Claim 2] A control means is a power unit according to claim 1 characterized by opening the 1st switching means when said detection current value after progress of the 1st predetermined time is over the 2nd predetermined threshold from the main power supply injection while detecting the current value which flows to current-limiting resistance.
[Claim 3] In the X-ray CT scanner which reconfigurates CT tomogram for this analyte based on the projection data of the analyte which was equipped with the X-ray tube and X-ray detector which carry out phase opposite on both sides of analyte, and were collected from this X-ray detector It is a console for performing power-source ON/OFF actuation of the power unit according to claim 1 or 2 for carrying out high-pressure electric supply, and an X-ray CT scanner in an X-ray tube. the purport which carried out open control of the 1st switching means from said power unit -- and -- or the X-ray CT scanner characterized by having a display means to perform the display which the malfunction detection signal used as the cause is notified, and corresponds.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to an X-ray CT scanner equipped with the power unit and this equipment of a switching regulator method which carry out switching control of the DC output obtained by rectifying and graduating AC input in more detail further about an X-ray CT scanner equipped with a power unit and this equipment, and generate a necessary stabilization DC electrical potential difference.
[0002] For example, although it is necessary to apply the high pressure DC stabilized by the rotating anode of an X-ray tube in an X-ray CT scanner, since an electrical potential difference is high and the current of the electrical potential difference is also large (20- 60-130kV, hundreds of mA), a switching regulator with sufficient conversion efficiency is used. However, if switching failures (short circuit etc.) occur for a solid-state-switching component, since there is not little effect which it has on other components of a circuit, to intercept a main power supply circuit promptly is desired.
[0003]
[Description of the Prior Art] Drawing 7 is drawing explaining the conventional power unit (switching regulator). In drawing the AC power of an input and FU/CB Vin A fuse or a circuit breaker, Current-limiting resistance for K1 to restrict a main power supply switch (relay contact), and for R1 restrict the rush current of a power up, A bypass switch for K2 to bypass the current-limiting resistance R1 after powering on (relay contact), The diode bridge by full wave rectification etc. and C0 D0 The capacitor for smooth (primary side tank capacitor), The switching element which C1 and C2 become from an insulated-gate bipolar transistor (IGBT:Insulated Gate Bipolar Transistor) etc. as for the capacitor for voltage division, and Q1 and Q2, As for the power control section by which the capacitor for smooth of a secondary and 45' control a choke coil as for the diode for rectification of a secondary, and L1, and, as for C3, T0 controls the main power supply injection sequence by the side of primary as for a pressure-up transformer, and D1 and D2, and TMa, a timer, and RL1 and RL2 are relays.
[0004] In addition, although not illustrated, the switching control circuit of Q1 and Q2 for carrying out stabilization control of the DC electrical potential difference of an output to others is prepared. Moreover, various high-tension circuits for obtaining necessary high pressure as a DC circuit of a secondary can be used. Moreover, switching element IGBT is the component which compounded MOS-FET and a bipolar transistor on 1 chip, and has the description of both components, like it is large the range [a switching rate with small control power is early, and] of the electrical potential difference and current to deal with of operation.
[0005] Hereafter, typical actuation of the power up by the starting configuration is explained. Transition of the current i of a power up (however, drawing shows the envelope of the AC input current i) is shown in an insertion Fig. (a). If set to powering-on signal PWRON=1, relay RL1 will carry out a pick and the main power supply switch K1 will close. At this time, since the bypass switch K2 is opened wide, it is rectified through the current-limiting resistance R1 in a diode bridge D0, and the AC input current i charges promptly the primary side capacitors C0-C2. Although the big rush current i tends to flow at this time, that peak current is restricted to Vin/R1 by existence of the current-limiting resistance R1, and the soft start of a primary side circuit is performed in this way.
[0006] Moreover, at this time, a secondary circuit is usually in a no-load (both Q1 and Q2 turn off) condition. Therefore, the primary side capacitors C0-C2 are charged quickly, and in connection with this, the AC input current i decreases exponentially, as shown in property ** of drawing. In this way, by

the time it goes through the predetermined time ta behind powering on, the AC input current i will decrease even on the level of extent with which a lost part in a primary side circuit is compensated small enough.
[0007] Then, when the predetermined time ta behind powering on passes, Timer TMa carries out a time-out, relay RL2 carries out a pick by this, and a bypass switch K2 closes. Although switching control of Q1 and Q2 is carried out and electric supply of them is attained after that at a DC load, the current i which flows to a primary side circuit at this time is smaller than the rush current.
[0008]
[Problem(s) to be Solved by the Invention] however -- although it is good when the above-mentioned power circuit operates normally -- a switching element Q1 -- and -- or -- if a failure is in the flow failures in Q2, or those control circuits -- Q1 of a power up -- and -- or the big current flowed to Q2, and when the worst, these components were damaged with the explosion. Moreover, the big current which flowed on that occasion had generated the 2nd order-failure referred to as doing damage to other normal circuit elements.
[0009] In order to avoid this, Fuse FU or a circuit breaker CB is usually formed, but generally, these component FU/CB has a high threshold setup for current cutoff, and it does damage to a power circuit not a little in order to take a certain amount of time amount to intercept a main power supply circuit. And also when re-setting these components, without also carrying out sufficient cause investigation when Fuse FU or Breaker CB flies and carrying out the reclosing of the power source, possibility of doing damage to a power circuit further by this was high not few.
[0010] This invention was made in view of the trouble of the above-mentioned conventional technique, and the place made into the purpose is to offer the X-ray CT scanner which detects the abnormalities of a power up exactly and is equipped with the power unit and this equipment which can intercept a main power supply circuit promptly.
[0011]
[Means for Solving the Problem] The above-mentioned technical problem is solved by the configuration of drawing 1 (A). Namely, the power unit of this invention (1) is set to the power unit of the switching regulator method which carries out switching control of the DC output obtained by rectifying and graduating AC input further, and generates a necessary stabilization DC electrical potential difference. The 1st switching means K1 which opens and closes the main power supply input way of AC, and the current-limiting resistance R1 for being prepared in said 1st switching means and serial, and restricting AC rush current of a power up, While detecting the 2nd switching means K2 which is prepared in said current-limiting resistance and juxtaposition, is closed after progress of the 1st predetermined time ta from a main power supply injection, and bypasses said current-limiting resistance circuit, and the current value concerning AC input When said detection current value at the time of progress of the 2nd predetermined time tb is over the 1st predetermined threshold TH1 from the main power supply injection, it has the control means 1 which opens the 1st switching means K1.
[0012] Transition of the AC input current i of a power up (news defeat) is shown in drawing 1 (B). As for property **, the case where a power circuit is normal is shown, while the rush current i in this case decreases promptly as the charge to a smoothing circuit progresses, it is decreasing even to the small current value of the abbreviation regularity of extent with which a lost part in a primary side circuit is compensated by the 2nd predetermined time tb, and this condition is considered to continue to the time amount tc by which the switching control of a secondary circuit is started.
[0013] Moreover, property ** shows the case where a switching element Q1 or Q2 is a short circuit failure, and in this case, as a result of connecting the primary side coil (current change delay element) of a transformer T0 to a smoothing circuit and juxtaposition through the failure component Q1 or Q2, it will continue flowing to a primary time amount side circuit longer than the case where the comparatively big rush current i is usual (property **).
[0014] Both property **s show the case where switching elements Q1 and Q2 are short circuit failures, and the big rush current i continues flowing from the time of powering on in this case. Therefore, in property **, it is normal, and when other (property **, property **, etc.), it can be judged that it is unusual.
[0015] Then, in this invention (1), the 1st predetermined threshold TH1 and 2nd predetermined time tb are defined like illustration, and when said detection current value at the time of progress of the 2nd predetermined time tb is over the 1st predetermined threshold TH1 from the main power supply injection, a control means 1 opens the 1st switching means K1, while detecting the current value

concerning AC input. Therefore, the abnormalities in the primary side circuit of a switching regulator are exactly detected to the power up, and cutoff of a main power supply circuit is attained promptly.
[0016] In addition, like illustration, the current value i concerning AC input may be detected before rectification, or may be detected after rectification. Moreover, although drawing 1 showed the case of ta>tb, it is clear that you may become the relation of ta<tb with the equipment which connects the 2nd switching means K2 a little early.
[0017] Preferably, in this invention (2), in above-mentioned this invention (1), when said detection current value after progress of the 1st predetermined time ta is over the 2nd predetermined threshold TH2 from the main power supply injection, a control means 1 opens the 1st switching means, while detecting the current value which flows to the current-limiting resistance R1.
[0018] By the way, according to above-mentioned this invention (1), as a result of carrying out closing control of the 2nd switching means K2 after progress of the 1st predetermined time ta from a main power supply injection, the current i to which this 2nd switching means K flows to the subsequent current-limiting resistance R1 in the limitation which operates normally (closing) should serve as abbreviation 0. However, if 2nd switching means K is not closed normally, as a result of a current's continuing flowing through the current-limiting resistance R1 also after that, becoming waste of power, and when the worst, the current-limiting resistance R1 will be able to be burned off.
[0019] Then, in this invention (2), when said detection current value after progress of the 1st predetermined time ta is over the 2nd predetermined threshold TH2 from the main power supply injection, a control means 1 opens the 1st switching means K1, while detecting the current value which flows to the current-limiting resistance R1. Therefore, the abnormalities of a power up are detected exactly and cutoff of a main power supply circuit is attained promptly.
[0020] Moreover, the X-ray CT scanner of this invention (3) is equipped with the X-ray tube and X-ray detector which carry out phase opposite on both sides of analyte, and sets them to the X-ray CT scanner which reconfigurates CT tomogram for this analyte based on the projection data of the analyte collected from this X-ray detector. It is a console for performing power-source ON/OFF actuation of the power unit according to claim 1 or 2 for carrying out high-pressure electric supply, and an X-ray CT scanner in an X-ray tube. the purport which carried out open control of the 1st switching means K1 from said power unit -- and -- or it has a display means to perform the display which the malfunction detection signal used as the cause is notified, and corresponds.
[0021] Therefore, generating of the explosion in a power supply section can be prevented, and the anxiety given to an operator and the subject can be avoided. moreover, an operator -- generating of a power failure -- and -- or the cause of a failure can be known promptly and this can be coped with proper.
[0022]
[Embodiment of the Invention] Hereafter, according to an accompanying drawing, the gestalt of the suitable operation for this invention is explained to a detail. In addition, the same sign is taken as the same or the thing which shows a considerable part through a complete diagram.
[0023] Drawing 2 is the important section block diagram of the X-ray CT scanner by the gestalt of operation, and shows the case where it has the power unit built over this invention for high-pressure electric supply of an X-ray tube. In drawing, the actuation console section in which a user operates 10, the photography table which 20 carries analyte 100 and is moved in the direction of a body axis, and 30 are scan gantries which perform AKISHARU (Axial) / helical (Herical) scan, and reading of analyte by the X-ray fan beam.
[0024] The X-ray control section by which 40 controls the X-ray tube of a rotating-anode mold, and 41 controls tube voltage kV, the tube electric current mA, the exposure time amount Sec, etc. of X-ray tube 40 in the scan gantry 30, A power unit for 42 to carry out high-pressure electric supply in the rotating anode of X-ray tube 40, the collimator with which 50 restricts the exposure range of the direction of a body axis of an X-ray, The X-ray detector array by which, as for 51, many (about n= 1000) X-ray detectors are arranged by the collimator control section, and 70 is arranged by radii-like a single tier or two or more trains (XDA), the data collection section (DAS) in which 80 collects the detection data (projection data) of an X-ray detector array, and 60 -- the scan gantry 30 -- analyte -- it is the roll control section which makes it rotate around a body axis.
[0025] The central processing unit with which 11 performs main control and processings of an X-ray CT scanner (scanning planned processing, scanning control, CT fault image reconstruction processing, etc.) in the actuation console section 10, The main memory for which, as for 11a, CPU11a uses the CPU and

11b (MEM), A display for the input unit with which 12 contains a keyboard, a mouse, etc., and 13 to display a scanning plan screen, CT tomogram for a scanning result, etc. (CRT), The control interface with which 14 exchanges the various control signals C (the power-source ON/OFF signal PWRON over a power unit 42 is included), and the various monitor signals SD (the malfunction detection signal MFD from a power unit 42 is included) between CPU11a, and the scan gantry 30 and the photography table 20, The secondary storages (disk etc.) which have memorized the capture buffer in which 15 accumulates the projection data from the data collection section 80, various data, an application program which need 16 for employment of an X-ray CT scanner, etc., and 17 are the common buses of CPU11a.
[0026] By the starting configuration, incidence of the fan beams from X-ray tube 40 is carried out to the X-ray detector array 70 all at once through analyte 100. The data collection section 80 scans and collects the detection data (projection data) of the X-ray detector array 70, and stores them in a capture buffer 15. Furthermore, while the scan gantry 30 performs the same projection as the above and collects and accumulates the projection data for scan gantry 1 rotation in this way with each view which rotated slightly, according to AKISHARU/helical scan, the photography table 20 is moved in the direction of a body axis intermittently/continuously, and all the projection data about the necessary image pick-up field of analyte 100 is collected and accumulated in this way. And CPU11a reconfigurates CT tomogram for analyte 100 based on all the obtained projection data, and displays it on a display 13.
[0027] Moreover, while performing power-source ON/OFF control of a power unit 42 according to powering-on button grabbing which is not illustrated in the actuation console 10, when a certain abnormalities (failure) are detected in a power unit 42, it displays on the display lamps (LED etc.) in which the information on to that effect was prepared by the display 13 or the console panel. Hereafter, the power unit 42 by the gestalt of this operation is explained to a detail.
[0028] Drawing 3 is drawing showing the configuration of the power unit by the gestalt of operation, and the current detecting element which detects the current which CS requires for a current sensor and 43 requires for AC input, the malfunction detection section which detects the abnormalities of the current which 44 requires for AC input, and 45 are the power control sections which perform injection / discharge control of a main power supply in drawing. About other configurations, it is the same as that of what was stated by above-mentioned drawing 7 , and is good. Hereafter, normal actuation of the power up by the starting configuration is explained. Transition of the current i in the case of being normal of a power up (however, drawing shows the envelope of the AC input current i) is shown in an insertion Fig. (a).
[0029] When the malfunction detection section 44 has not detected abnormalities in the initial state, both the malfunction detection signals MFD1 and MFD2 are LOW level "=0", and, therefore, the output of the NOR-gate circuit NO1 is HIGH level "=1." If set to powering-on signal PWRON=1 in this condition, the AND-gate circuit A1 will be satisfied, relay RL1 will carry out a pick, and the main power supply switch K1 will close. At this time, since the bypass switch K2 is opened wide, it is rectified through the current-limiting resistance R1 in a diode bridge D0, and the AC input current i charges promptly the primary side capacitors C0-C2. Although the big rush current i tends to flow at this time, that peak current is restricted to Vin/R1 by existence of the current-limiting resistance R1, and the soft start of a primary side circuit is performed in this way.
[0030] Furthermore, after the above-mentioned powering on, if it goes through predetermined time tb, Timer TMb will carry out a time-out and the detection enable signal DEG1 for detecting the abnormalities of a switching element Q1 and Q2 grade will be energized between predetermined time. Moreover, after the above-mentioned powering on, if it goes through predetermined time ta, while Timer TMa will carry out a time-out, will carry out the pick of the relay RL2 with the output signal and will close a bypass switch K2, the detection enable signal DEG2 for detecting the abnormalities of a bypass switch K2 of operation is generated by delaying this signal in a delay circuit DL 1. Although these signals DEG1 and DEG2 are added to the malfunction detection section 44, in order that there may be no abnormalities in a power circuit, in this example, a powering-on sequence progresses normally hereafter.
[0031] Drawing 4 is drawing showing the example of a configuration of the current detecting element by the gestalt of operation, and drawing 4 (A) inserts the small resistance R in a serial at the arbitration path of the AC input current i, detects and amplifies the voltage drop with the differential amplifier DFA, and shows the case where the corresponding voltage signal Di is outputted. Drawing 4 (B) shows the case where detect and amplify the voltage drop in the current-limiting resistance R1 with the differential amplifier DFA, and the corresponding voltage signal Di is outputted. Drawing 4 (C) arranges current

sensor (coil for pickup) CS for the path of the AC input current i, and shows the case where detect and amplify the electrical potential difference in which induction was carried out by the current field with the differential amplifier DFA, and the corresponding voltage signal Di is outputted.
[0032] Drawing 5 and drawing 6 are drawing (1) explaining the malfunction detection section by the gestalt of operation, and (2), and drawing 5 (A) shows the configuration of malfunction detection section 44A for detecting the abnormalities of a switching element Q1 and Q2 grade. Moreover, the timing chart of operation is shown in drawing 5 (B). For example, the resistance partial pressure circuits Ra and Rb generate threshold voltage TH1. In Di>TH1, by comparing the detecting signal Di and threshold TH1 of the current detecting element 43, a comparator CMP 1 outputs HIGH level to the output. Since the AC input current i is an alternating current, the detecting signal Di (= vac) is also an alternating current, and, therefore, as for the case of Di>TH1, 1 or two or more pulse signals are obtained from the output of a comparator CMP 1.
[0033] The counter CTR 1 has counted said pulse signal in the section of the detection enable signal DEG 1= 1, and if the number of counts of an output turns into a predetermined number, it will output the malfunction detection signal MFD 1= 1 (abnormalities), while being reset by the power-on-reset signal PWR. Moreover, the input of the AND-gate circuit A2 is de-energized by this malfunction detection signal MFD 1= 1, and, thereby, the condition of the malfunction detection signal MFD 1= 1 is held. The reason for having formed the counter CTR 1 is because the abnormality signal MFD 1= 1 will not be accidentally detected by the noise etc., and configurations various otherwise can be used for it.
[0034] In drawing 5 (B), when a power circuit is normal **, a pulse signal is not generated at the section of DEG 1= 1, and therefore, the abnormality signal MFD 1= 1 is not detected. Moreover, when a switching element Q1 or Q2 is [short circuit failures or these drive control circuits] the abnormalities in ON control, AC input current changes like property **, and, therefore, 1 or two or more pulse signals occur at the section of DEG 1= 1. Therefore, the abnormality signal MFD 1= 1 is detected. Moreover, when switching elements Q1 and Q2 are [short circuit failures or these drive control circuits] the abnormalities in ON control, AC input current changes like property **, and, therefore, 1 or two or more pulse signals occur at the section of DEG 1= 1. Therefore, the abnormality signal MFD 1= 1 is detected.
[0035] In addition, although the property of expressing various abnormal conditions may exist also between the above-mentioned normal property **, and abnormality property ** and **, various abnormal conditions are detectable proper by choosing suitably the generating timing and its gate signal width of face of the level of a threshold TH1, and the detection enable signal DEG1.
[0036] Drawing 6 (A) shows the configuration of malfunction detection section 44B for detecting the abnormalities of a bypass switch K2 of operation. Moreover, the timing chart of operation is shown in drawing 6 (B). In addition, the current detecting element 43 of this example shall have detected the voltage drop in the current-limiting resistance R1.
[0037] For example, the resistance partial pressure circuits Rc and Rd generate threshold voltage TH2. In Di>TH2, by comparing the detecting signal Di and threshold TH2 of the current detecting element 43, a comparator CMP 2 outputs 1 or two or more pulse signals to the output. The counter CTR 2 has counted said pulse signal in the section of the detection enable signal DEG 2= 1, and if the number of counts of an output turns into a predetermined number, it will output the malfunction detection signal MFD 2= 1 (abnormalities) of a bypass switch K2, while being reset by the power-on-reset signal PWR. Moreover, the input of AND-gate circuit A3 is de-energized by this malfunction detection signal MFD 2= 1, and, thereby, the condition of the malfunction detection signal MFD 2= 1 is held.
[0038] In drawing 6 (B), since the path of the current-limiting resistance R1 will be bypassed by the bypass switch K2 after Timing ta if it is usual, the voltage drop in the current-limiting resistance R1 must be abbreviation 0. Normal property ** shows this. However, when a bypass switch K2 is not closed by abnormalities, such as relay RL2 or its control circuit, as shown in abnormality property **, also after that, the AC input current i continues flowing to the current-limiting resistance R1, and, thereby, a pulse signal is generated by Di>TH2 in the section of the detection enable signal DEG 2= 1. And if the number of counts of a counter output turns into a predetermined number, the malfunction detection signal MFD 2= 1 (abnormalities) of a bypass switch K2 will be outputted.
[0039] In addition, although the gestalt of the suitable operation for above-mentioned this invention was described, within limits which do not deviate from this invention thought, the configuration of each part and control are performed and various change of these combination cannot be made also until it says.
[0040]
[Effect of the Invention] As stated above, while according to this invention being able to detect exactly

the abnormalities in the primary side circuit of a switching regulator to the power up and being able to intercept a main power supply circuit promptly, expansion of the failure by an excessive current flowing for a primary side-circuit component is effectively avoidable. Moreover, an X-ray CT scanner equipped with this power unit etc. can be applied to insurance.

[Translation done.]

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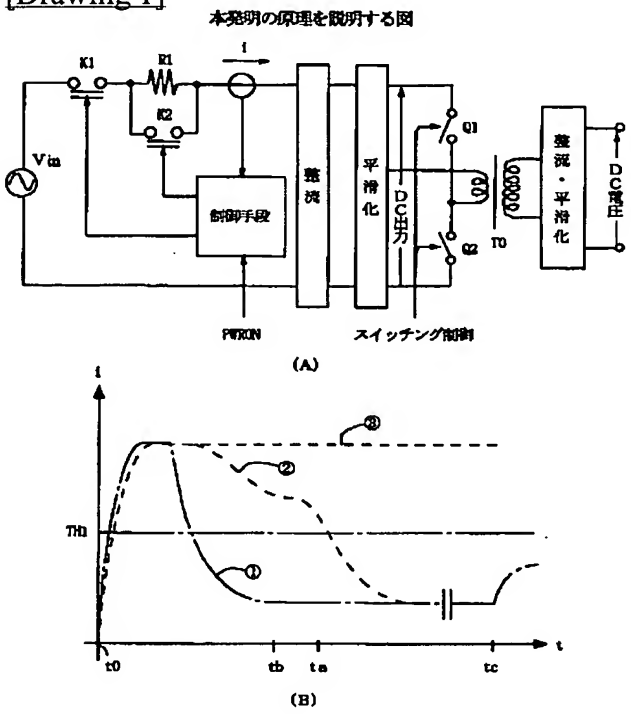
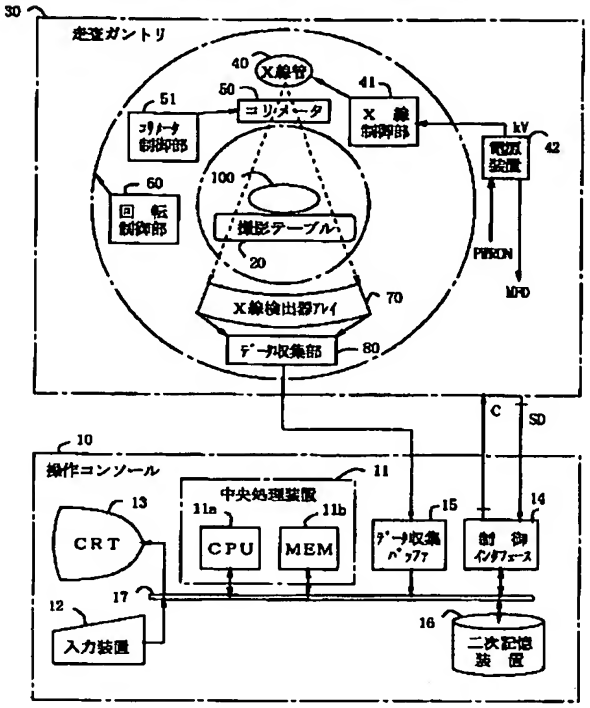
DRAWINGS

[Drawing 1]



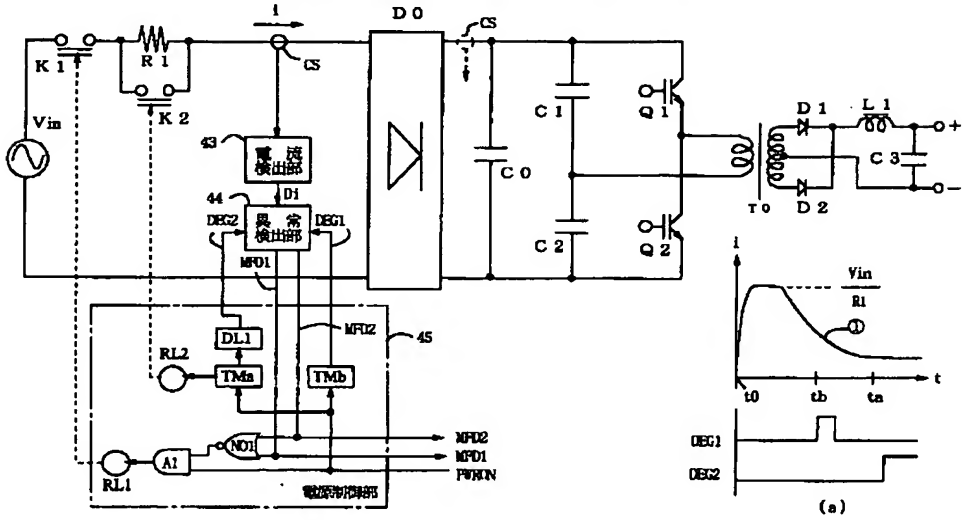
[Drawing 2]

実施の形態によるX線CT装置の要部構成図



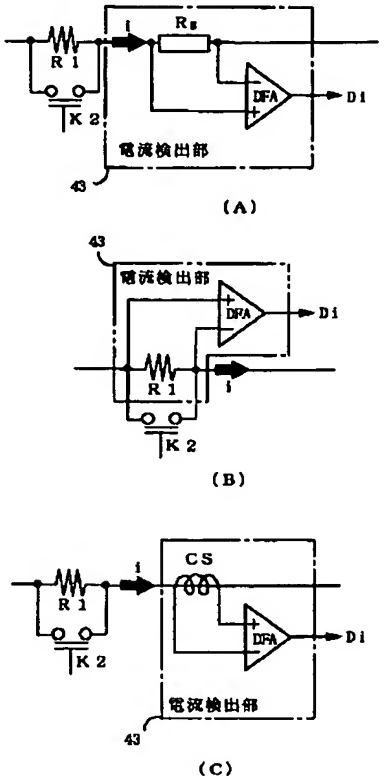
[Drawing 3]

実施の形態による電源装置の構成を示す図



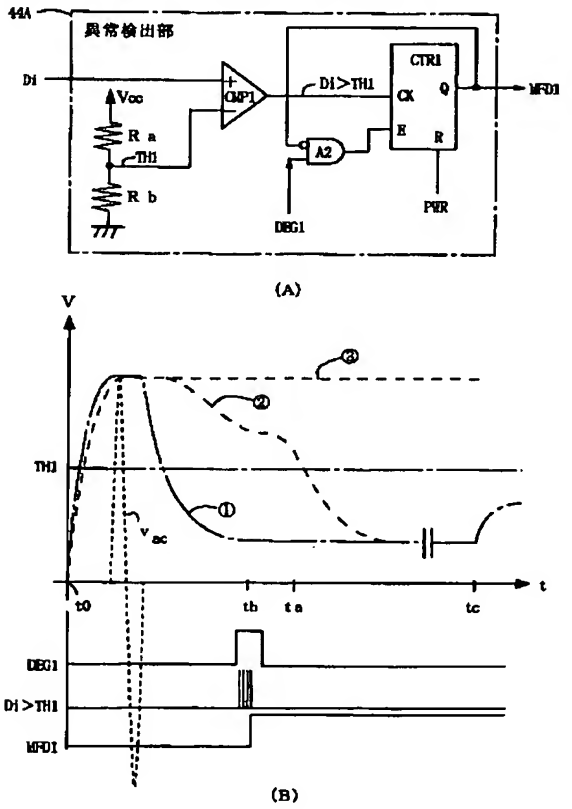
[Drawing 4]

実施の形態による電流検出部の構成例を示す図



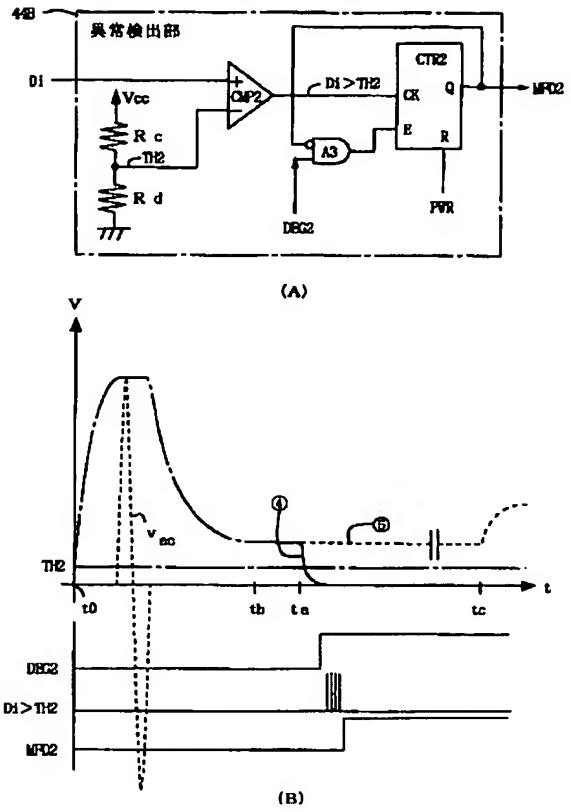
[Drawing 5]

実施の形態による異常検出部を説明する図（1）



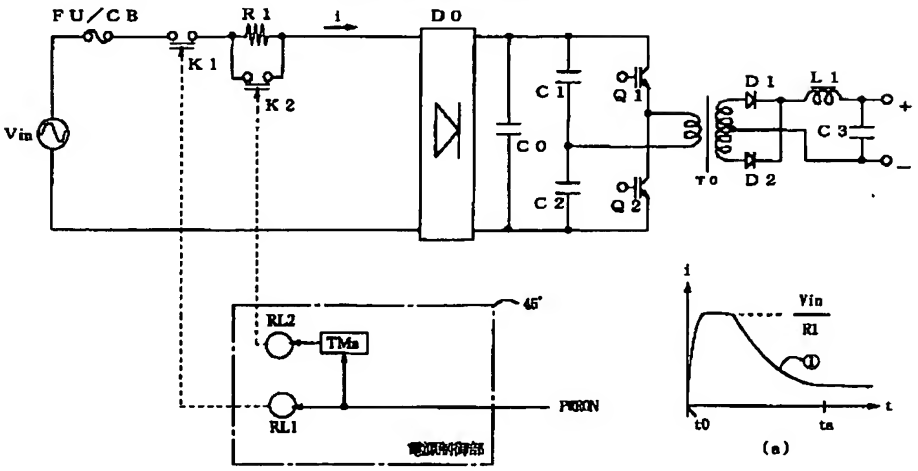
[Drawing 6]

実施の形態による異常検出部を説明する図（2）



[Drawing 7]

従来の電源装置を説明する図



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